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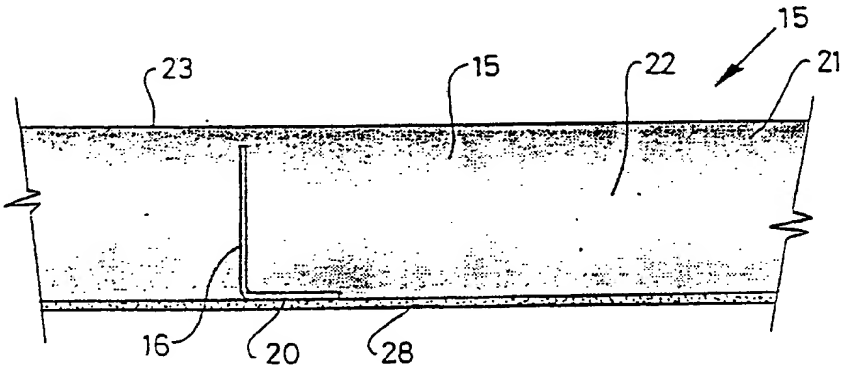
(54) Title: IMPROVED BUILDING SYSTEMS



(57) Abstract

A building panel (12) comprises a foam plastics core (15) which encapsulates frame members (16, 17 and 18) of a panel perimeter frame assembly and secures a structural panel (28) to one side of the perimeter frame assembly. The opposite side of the panel is suitably moulded integrally with the core as a structural face panel (21). This face panel (21) is suitably formed from a dense form of the core material.

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having an internal upstanding flange 41 and an inwardly directed channel portion 42. Suitably the channel portion 42 receives the edge of a concrete floor 43 cast within the perimeter frames 40. The upstanding flange 41 is secured by suitable mechanical fastenings as illustrated at 42 to the lower edge of the wall 12, 13 and 14 by the fastening passing into the return flange 20 of the encapsulated angle frame 25. The panels 12, 13 and 14 are abutted together and sealed with a mastic. Of course if desired, the perimeter frames 18 could be stepped for complementary rebated engagement with one another.

A ridge beam assembly one end of which is illustrated at 50 includes opposed end mounting plates 51 adapted to be secured to the respective apexes 52 of the end wall frames 14 to span the full distance between end walls. For this purpose the ridge beam 50 includes a lower roll-formed section 53 as illustrated in FIG 7 and capped with a roll-formed capping section 54 which is secured by fasteners to the ribs 55. In this manner a beam is formed having opposed channel shaped recesses 56 adapted to receive the upper ends of roof panels 30.

The upper end of the side walls are provided with roll-formed cappings 60 as illustrated in FIG 8 has a side flange 61 which connects to the return faces 20 of the encapsulated angle frame 15 and an angled top flange 62 which protrudes

IMPROVED BUILDING SYSTEMS

This invention relates to improved building systems and components therefore.

This invention has particular application to the construction of low cost housing but of course it is not limited to such application as it can be utilised for other commercial, industrial or temporary constructions. However for illustrative purposes particular reference will be made hereinafter to its application to low cost structures.

There have been many attempts to provide low cost housing for under-developed countries. Mostly these attempts have centered around the provision of a kit form house comprising framing and panels of conventional form. Unfortunately there are many disadvantages associated with such kits, including the use of materials which are heavy and difficult to transport to building sites which may not be readily accessible by road. They may require skilled labour for their erection and in order to maintain the cost to a minimum, low quality materials are often used and this leads to rapid decay and shortened life of the building, especially when they are not correctly maintained.

The present invention aims to alleviate the above disadvantages and to provide improved building systems and methods and components therefore which will be reliable and

efficient in use. Other objects and advantages of this invention will hereinafter become apparent.

With the foregoing and other objects in view, this invention in one aspect resides broadly in a structural building module including a pair of opposed faces supported in spaced apart relationship by a core of foamed plastics material, said core being relatively dense adjacent at least one said opposed face and less dense intermediate said opposed faces. Preferably one of the opposed faces is moulded from plastics material integrally with the core and the other opposed face is constituted by the outer face of a panel bonded or otherwise secured to said core such as by being fastened to a frame within the core. Of course if desired both the opposed faces could be constituted by the outer faces of respective panels secured to the core or they could be formed of plastics material integrally with the core.

In the preferred form one opposed face is formed from plastics material integrally with the core and constitutes an outer face. This outer face may be moulded to provide a decorative surface finish and the plastics material may be pigmented and otherwise modified such as for minimising degradation by ultra-violet radiation as desired. The other opposed face which constitutes the inner face is suitably formed from a panel material which has a flat outer surface

which can be prefinished, painted or otherwise decorated. The panel may be a metal panel, a fibrous cement panel or a plywood or plaster panel. Of course if desired a surfacing gel coat could be formed from a different plastics material to that of the plastics material from which the core and the relatively dense portion of the core is formed. Additionally, the core material could be injected into a space formed between the opposed faces if desired.

In the preferred form of the module, the gel coat is formed from a dense polyurethane material as is the outer skin of the panel adjacent the gel coat. The core is formed from a foamed polyurethane material and in such manner that the foamed plastics material is relatively dense adjacent the skin and becomes less dense to form a core of low density foamed polyurethane material. It is also preferred that the outer skin and/or the relatively dense foamed plastics material be reinforced with a suitable tensile material such as chopped fibre-glass strands or wire mesh or expanded metal.

The module is preferably in the form of a rectangular panel which includes an internal frame encapsulated within the foamed plastics core material. The frame could be formed of any suitable material such as wood or plastics material but preferably the frame is formed from roll formed metal sections. The metal sections may be galvanized sheet steel

sections or they may be expanded metal sections. In the preferred form the metal sections are angle sections. Preferably the metal frame is exposed about the perimeter of the module so that fittings or connectors may be screwed or fastened directly thereto and whereby panels may be abutted in close side by side relationship.

The invention may be also adapted to provide non-structural cladding panel of the type having molded outer surface and a backing of formed plastics material which is relatively dense adjacent the outer surface and less dense inwardly thereof and formed as one side portion of the module described above.

In a further aspect this invention resides broadly in a method of forming a building module of the type described above, the method including:-

providing a mould surface upon which a plastics laminate may be formed;

providing a confinement about said mould surface into which plastics material may be deposited;

forming a first layer of dense plastics material on said mould surface;

building up said first layer with relatively dense plastics material to form a skin;

forming a further layer or layers of foamed plastics material onto said skin to form a core and to build up said

module to substantially the finished thickness of said module, and

securing a panel to said core in opposition to said skin.

The mould surface may incorporate features such as brick bond construction, stucco type surface finish or other decorative finish and of course it can be corrugated or stepped in the form of tiles as desired. The confinement may be constituted by the walls of a mould or they may be constituted by the perimeter members of a frame adapted to be substantially encapsulated by the foamed plastics core material. The dense plastics material may be formed on the mould surface by injection or by depositing the material by spray gun, and of course the desired thickness may be built up in one pass or in a plurality of passes of the gun and in each pass the density of the plastics material deposited may be varied and/or preferably reduced. The foamed plastics material may also be deposited together with reinforcing materials such as chopped fibrous glass rovings adapted to be encapsulated with the foamed plastics material.

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate typical embodiments of the invention and wherein:-

FIG 1 is a perspective view of a typical dwelling formed

from panels to according the present invention;

FIG 2 illustrates the framing arrangement of the panels which form one end wall of the dwelling illustrated in FIG 1;

FIG 3 is a cross-sectional view of a typical panel;

FIG 4 is an enlarged cross-sectional view of a portion of the panel illustrated in FIG 3;

FIG 5 is a perspective view showing details of the ridge beam;

FIG 6 is an end view illustrating the method of construction of the ridge beam;

FIG 7 illustrates a typical wall beam capping;

FIG 8 illustrates the details of the wall to floor joint;

FIG 9 is a perspective view of a typical roofing panel;

FIG 10 is an enlarged cross-sectional view of portion of the roofing illustrated in FIG 9, and

FIG 11 illustrates a further roof panel according to this invention.

As shown in FIGS 1 and 2, a typical dwelling 10 formed in accordance with the present invention includes side walls 11 formed from a plurality of panels, such as the panels 12, 13 and 14 illustrated in FIG 2. Some of the panels are provided with window openings as illustrated. Suitably the door and window openings are framed with rebated

roll formed metal sections formed integrally with their respective internal frame which may comprise joists and nogging, which as illustrated in FIG 2 in respect of the panel 12 includes a frame 15 comprising joists 16 and nogging 17.

The internal frame 15 has peripheral members 18 formed as angles which extend about the periphery of each panel and between which the respective joists 16 and nogging 17 extend. In this embodiment the joists 16, nogging 17 and the peripheral frame members 18 are all formed from roll formed metal angle and are disposed with one flange 20 of the angles in a common plane. Each panel is formed in a mould provided with a patterned surface, in this case a brick running bond pattern which forms the exterior face 24 of each panel.

The panels are formed by depositing a first layer of dense polyurethane thermo setting resin which is pigmented and modified before the polyurethane resin is deposited into the mould and after a suitable release agent has been applied thereto. The first layer forms a decorative gel coat. Further coats of dense polyurethane resin are sprayed into the mould to build up a thick tough skin 21 whereupon a foaming agent is introduced to the polyurethane resin, initially in small amounts, so that further layers 22 of relatively dense polyurethane resin are sprayed onto the skin 21. These layers are alternated with layers of chopped

rovings which are also deposited by chopper gun prior to setting of the thermo- setting resin. In this manner a relatively dense face portion 23 of reinforced polyurethane material is formed which may have a thickness of approximately 4 to 10 millimeters.

A prepared metal frame 15 as shown in FIG 4 is then inserted into the mould with the outer peripheral faces 26 flush against the side walls of the mould. Further foamed polyurethane resin is then deposited into the mould to encapsulate the frame 15. For this purpose the spray guns are robotically controlled to stop and start and angle the jet of resin into the mould so as to ensure that no voids are formed beneath returned flanges 20 of the angle frame members 16, 17 and 18. The foam core is built up in this matter by applying successive layers of less dense material until it is approximately half its full thickness. The remainder of the core 15 may be built up at the same or approximately the same density or it may be gradually increased so as to provide a more dense foamed plastics material adjacent the fibrous cement panel 28 which is bonded to the panel by being placed thereon prior to setting of the thermo-setting foamed plastics polyurethane material from which the core 15 is formed. In this manner the core bonds to the frame assembly 15 and to the fibrous cement sheeting 28 to form an integral wall panel such as 12, 13 and 14 as illustrated in FIG 2.

The roof panels 30 as illustrated in FIGS 1, 10 and 11 are of corrugated form. They are formed in a similar manner to the wall panels with the exception that they do not incorporate an internal frame. Accordingly construction takes place by depositing the gel coat layer within the mould to form the external exposed surface of the corrugated roof panel and subsequently the core 31 is built up by forming a dense skin at 32 adjacent the outer surface of the panel 30 and a core 31 of progressively decreasing density, decreasing to a minimum density intermediate the roof panel. The density is then increased and a flat sheet steel panel 33 formed of galvanized steel or colour bonded steel with edge flanges 34 and 35 folded from the body of the sheet is supported on the core 31 prior to its setting so that it bonds to the metal panel 33.

It will be seen in FIG 10 that the side flanges 35 terminate at a point partway across a crest of respective corrugations. Thus panels 30 may be arranged in edge abutting relationship with the flanges 35 connected and sealed with a mastic if desired or simply connected by a capping of semi-cylindrical shape which extends across the part circular end corrugations of the adjoining panels to weatherproof the joint and to connect the panels together.

Referring to FIGS 6 to 9 it will be seen that the wall panels 12 to 14 are supported on a metal perimeter frame 40

outwardly beyond the wall panel 12, 13 or 14 so that mechanical fasteners may be secured from beneath through the flange 62 and into the metal under-side panel 33 of each roof panel 30.

Suitably the relatively dense portion of the foamed core is 4 to 6 millimeters deep and the overall depth of the panel is 75 millimeters.

Of course thicker panels can be utilized to form buildings which have good thermal insulation properties and of course the panels or modules may be formed in any desired shape to meet particular requirements. For example, FIG 12 illustrates a tapered roof panel 70 provided with upstanding side flanges 71 and adapted to be utilized with corresponding roof panels to form a multi-faceted peaked roof assembly which simulates a shingle roof.

It will of course be realised that the above has been given only by way of illustrative example of the invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is defined in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A structural building module including a pair of opposed faces supported in spaced apart relationship by a core of foamed plastics material, said core being relatively dense adjacent at least one said opposed face and less dense intermediate said opposed faces.

2. A structural building module according to claim 1, wherein the other said opposed face is the outer face of a panel bonded to said core.

3. A structural building module according to claim 1 or claim 2, wherein said one opposed face is the outer face of a structural skin formed from a plastics material.

4. A structural building module according to claim 3, wherein said plastics material from which said structural skin is formed is the same plastics material which is foamed to form said core.

5. A structural building module according to any one of the preceding claims, wherein said skin and/or said relatively dense core material is reinforced.

6. A structural building module according to claim 5, wherein said skin and/or said relatively dense core material is reinforced with randomly deposited strands of tensile material.

7. A structural building module according to claim 6, wherein said strands are fiberglass strands.

8. A structural building module according to any one of the preceding claims, wherein said plastics material is a polyurethane plastics material.

9. A structural building module according to any one of claims 3 to 8, wherein said skin includes an outer layer of plastics material deposited without a foaming agent and inner layers deposited with a foaming agent whereby the layers are built up to form progressively less dense layers.

10. A structural building module according to any one of the preceding claims, wherein said module includes an internal frame which is substantially encapsulated by said foamed plastics core material.

11. A structural building module according to claim 10, wherein said internal frame provides connections for

interconnecting adjacent said modules.

12. A structural building module according to any one of the preceding claims, wherein said plastics material at said one face is moulded to provide a decorative surface finish.

13. A structural building module according to any one of the claims 2 to 12, wherein said panel is a sheet metal panel.

14. A structural building panel according to any one of the preceding claims, wherein said module is in the form of a rectangular panel.

15. A method of forming a building module of the type defined in any one of the preceding claims, the method including:-

providing a mould surface upon which a plastics laminate may be formed;

providing a confinement about said mould surface into which plastics material may be deposited;

forming a first layer of dense plastics material on said mould surface;

building up said first layer with relatively dense plastics material to form a skin;

forming a further layer or layers of foamed plastics material onto said skin to form a core and to build up said module to substantially the finished thickness of said module, and

securing a panel to said core in opposition to said skin.

16. A method as defined in claim 15 and further including:-

inserting a frame assembly into said confinement after said skin is formed, and

substantially encapsulating said frame assembly with said foamed plastics core material.

17. A method as defined in claim 15 or claim 16, and further including:-

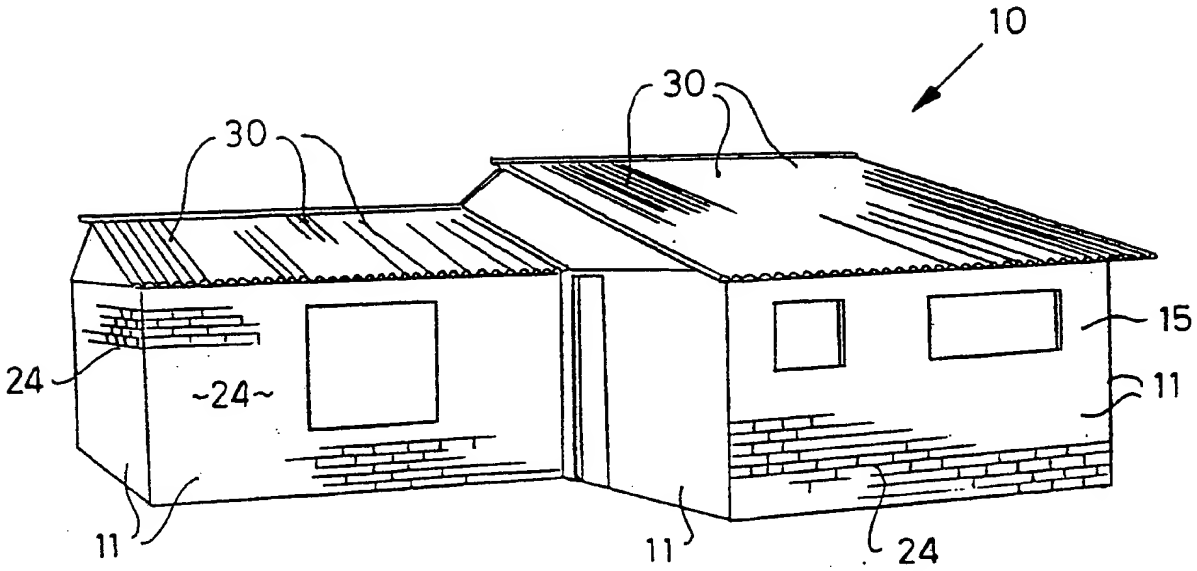
placing said panel onto said core prior to the setting of said core to cause said core to bond to said panel.

18. A method as defined in claim 15 and further including:-

reinforcing said skin with strands of tensile material prior to forming said core.

19. A method as defined in any one of claims 15 to 18 and further including:-

forming said skin by depositing layers of thermosetting


10
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24
24
11
11
11
24

FIG. 1

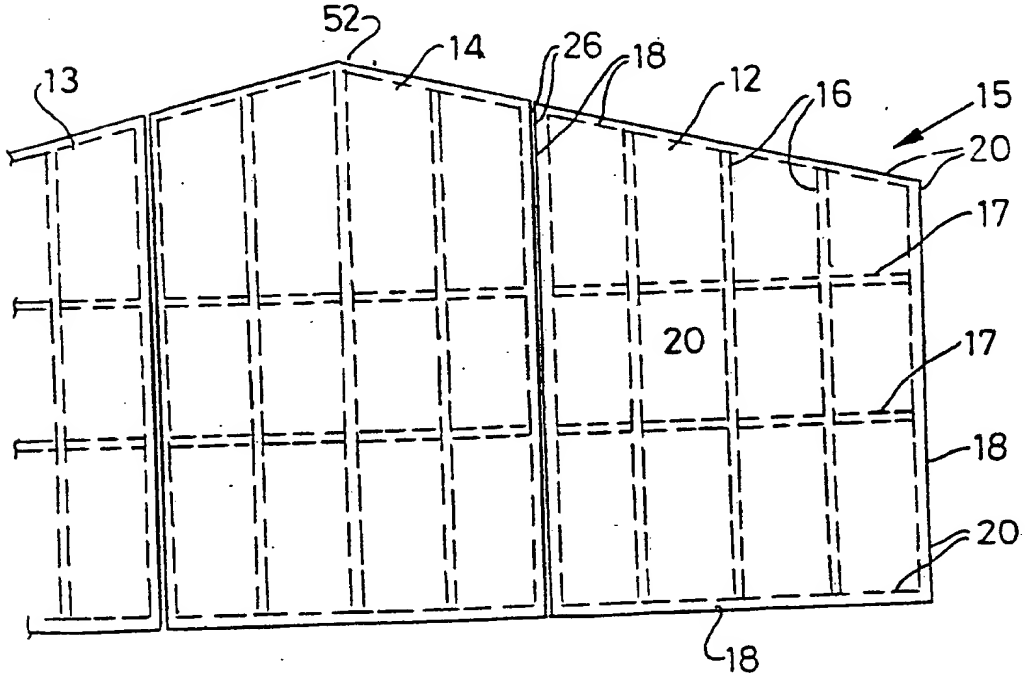
52
14
26
18
12
16
15
13
20
17
20
17
18
20
18

FIG. 2

liquid plastics material onto said mould surface;

reinforcing said skin by randomly depositing strands of fiberglass material between layers of thermosetting liquid plastics material for encapsulation therein, and

adding foaming agent to said thermosetting liquid plastics material and depositing said foamed thermosetting liquid plastics material onto said skin to form said core.

20. A method according to claim 19, wherein said plastics material is a polyurethane material deposited onto said mould surface from a spray gun.

21. A structural building module substantially as hereinbefore described with reference to the accompanying drawings.

22. A method of forming a building panel substantially as hereinbefore described.

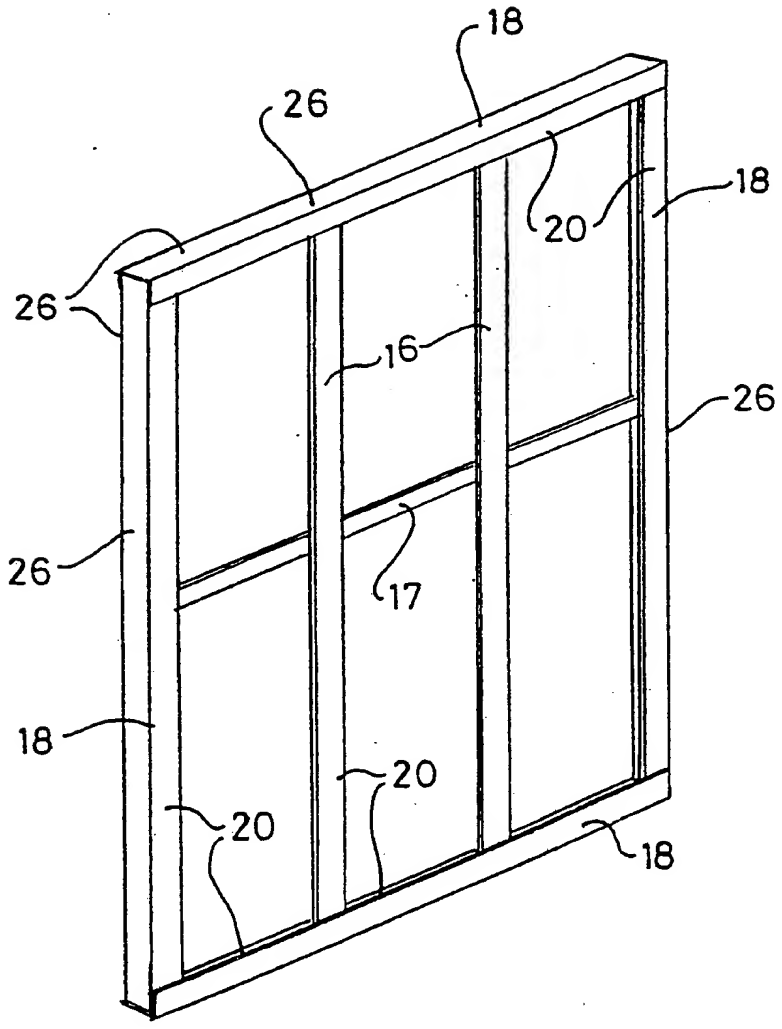

FIG. 4

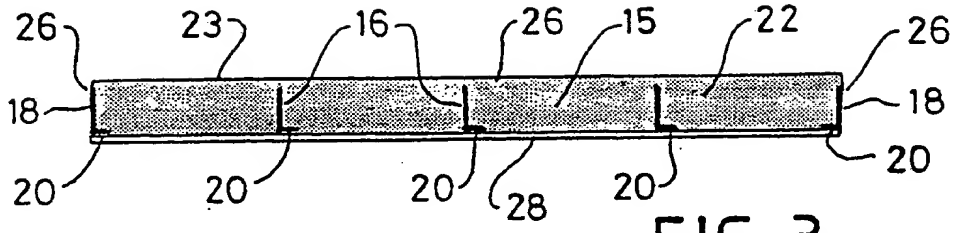

FIG. 3

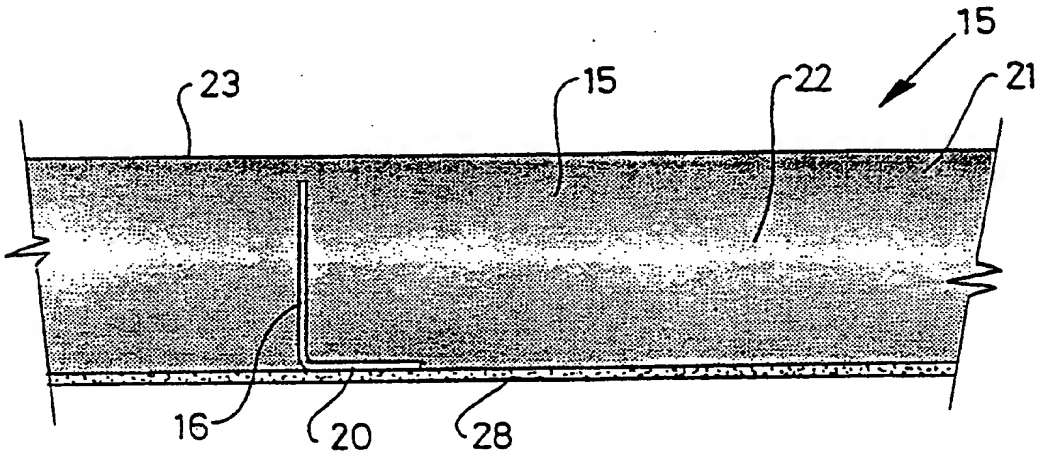

FIG. 5

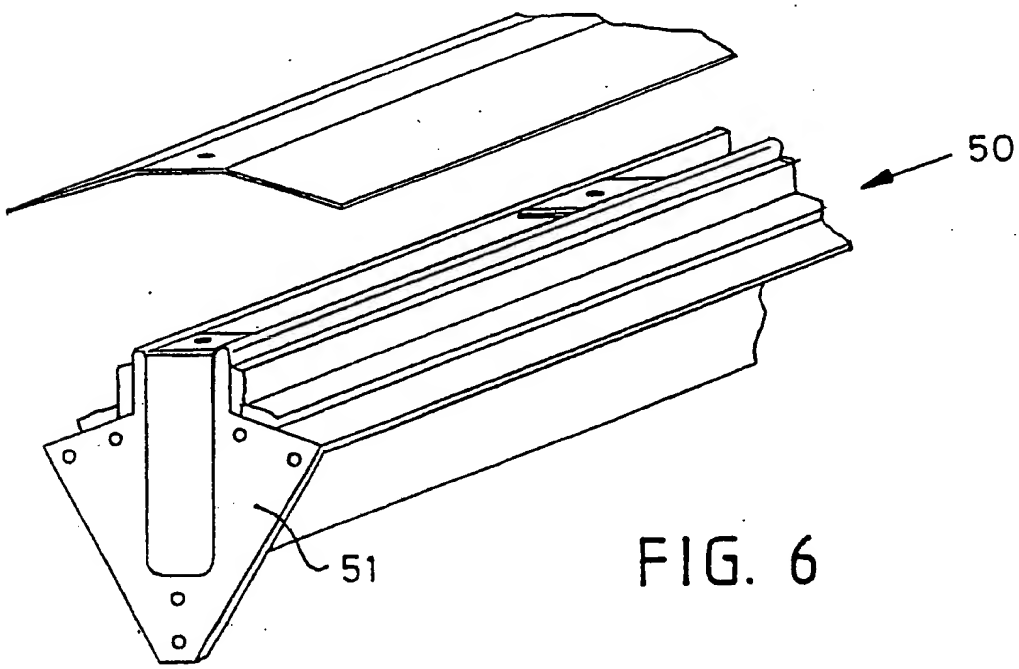

FIG. 6

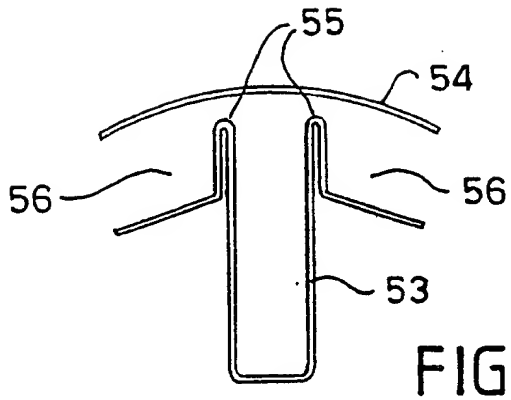

FIG. 7

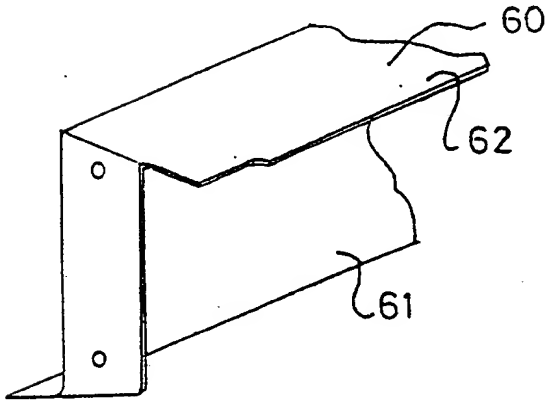

FIG. 8

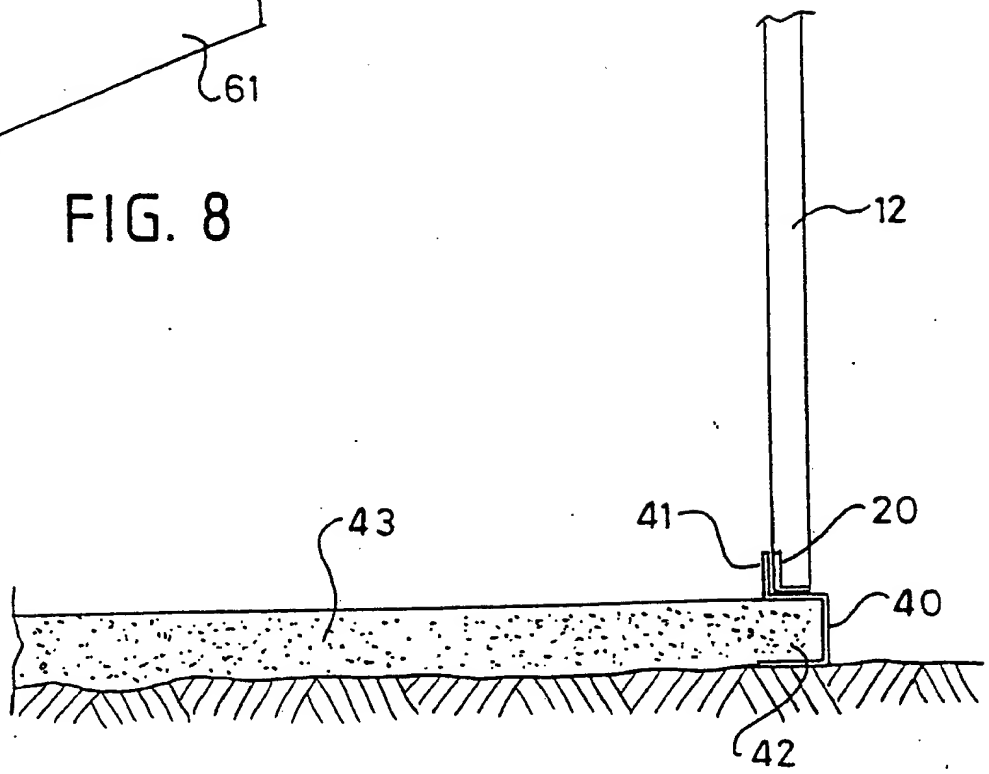

FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 88/00286

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] E04C 2/26, E04D 3/35, B32B 5/20, B29C 39/20

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	E04C 2/26, E04D 3/35, B32B 5/20, B29C 39/20 B29D 27/04

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched

AU: IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A, 4456706 (SIEDENSTRANG et al) 26 June 1984 (26.06.84)	(1-4,15)
X	US,A, 4038350 (JAQUES) 26 July 1977 (26.07.77)	(1-4,15).
X	US,A, 3709965 (CAMPBELL) 9 January 1973 (09.01.73)	(1-4,15)
X	US,A, 3608007 (HENRIKSON) 21 September 1971 (21.09.71)	(1-4,15)
X	US,A, 3476841 (BIENERT) 4 November 1969 (04.11.69)	(1-5,15)
X	US,A, 3410044 (MOOG) 12 November 1968 (12.11.68)	(1-5,15)
X	US,A, 3309439 (NONWEILER) 14 March 1967 (14.03.67)	(1-4,15)
X	WO,A, 87/05650 (VACUTEK HOLDINGS PTY LTD et al) 24 September 1987 (24.09.87)	(1-5,15)
X	GB,A, 1536876 (VEB LEUNA-WERKE "WALTER ULBRICHT") 20 December 1978 (20.12.78)	(1-4,15)
X	GB,A, 1254993 (NAPHTACHIMIE) 24 November 1971 (24.11.71)	(1-4,15)
X	EP,A, 253221 (THE CELOTEX CORP.) 20 January 1988 (20.01.88) (See claim 7)	(1-4,15)
A	FR,A, 2591147 (PARADIS) 12 June 1987 (12.06.87)	(1-5,15)

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8 November 1988 (08.11.88)	17 NOVEMBER 1988 (17.11.88)
International Searching Authority Australian Patent Office	**Signature of Authorized Officer** Hugh Ness HUGH NESS

Form PCT/ISA/210 (second sheet) (January 1985)

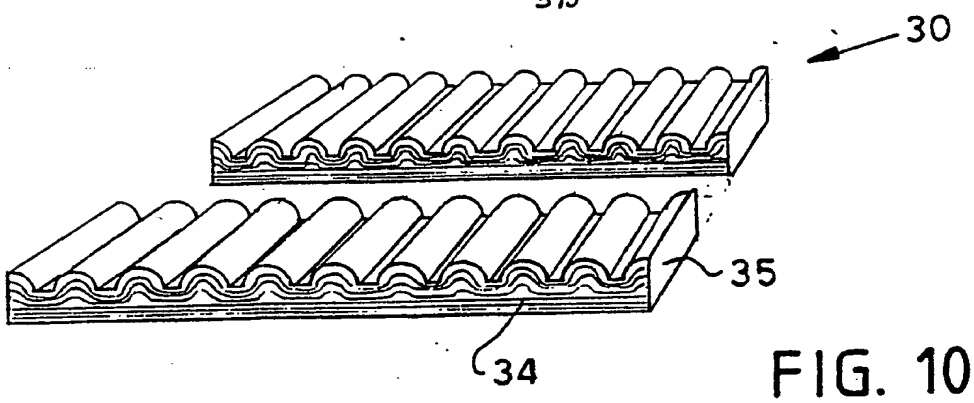

FIG. 10

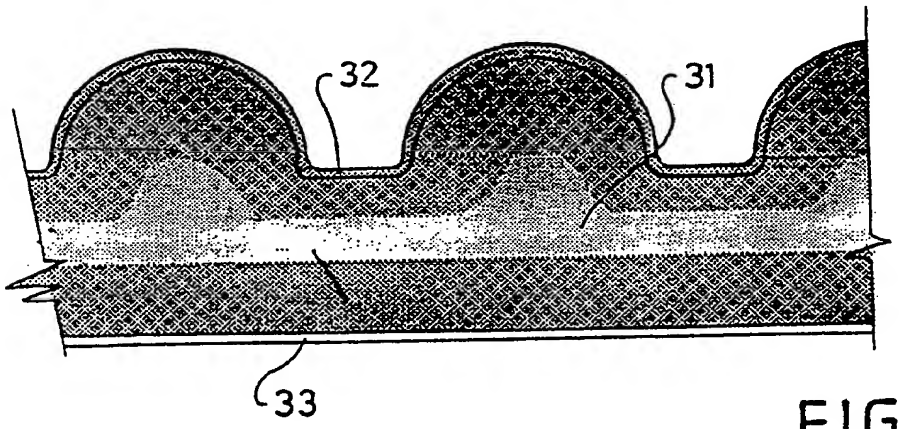

FIG. 11

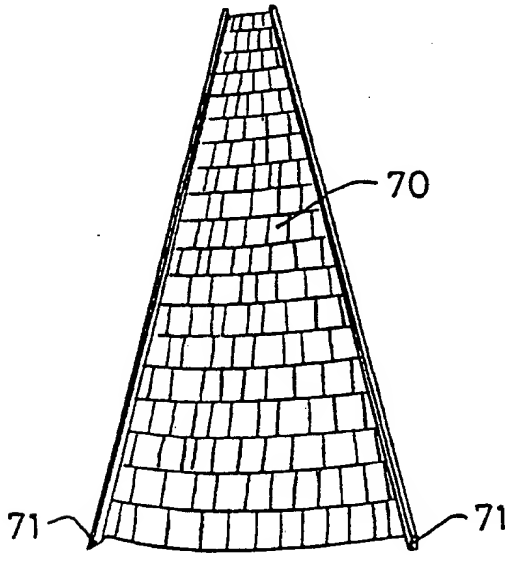

FIG. 12